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REVIEWS

Die Alpen im Eiszeitalter. Von DR. ALBRECHT PENCK, Professor an der Universität Berlin, und DR. EDUARD BRÜCKNER, Professor an der Universität Wien. Gekrönte Preisschrift. Leipzig: Chr. Herm. Tauchnitz, Verleger. In drei Bänden, S. xxxviii + 1200, mit 136 Abbildungen im text, 30 Tafeln, und 19 Karten. Vollständig in 11 Lieferungen à 5 Mark.

This voluminous work, by two of the leading glacialists of Europe, has been seven years in course of publication, the first Lieferung having appeared in December, 1901, and the eleventh or concluding Lieferung in December, 1908. It represents the vacation work of each of these authors for a period of about twenty-five years, and is largely a labor of love, the greater part of it having been carried on independent of official surveys and at private expense.

The plan of the work embraces three volumes, of which the first deals with the glaciations on the north of the eastern Alps, the second on the north of the western Alps, the third in the southern Alps and eastern end of the Alps. The paging, however, is continuous so that the entire work may be bound in a single volume and it has but a single index. The comprehensiveness of the treatment of results of the many studies carried on by various students is shown by the fact that there are 547 different authors either referred to or quoted.

In the first volume, which is entirely the work of Dr. Penck, after a brief setting forth of the problems involved and the methods of study pursued, and a brief outline of leading features in the northern portion of the eastern Alps, attention is first called to the gravel outwash aprons and lines of glacial drainage displayed in the Alpine foreland. The morainic belts are then discussed and then the feeding grounds of the glaciers. Overdeepening is discussed in considerable fulness in relation to the Inn valley system and the rules for overdeepening by glacial erosion are briefly considered.

It was in this field that Penck first worked out the intricacy of the glacial history, and it was done largely through a study of the out-wash phenomena or glacial drainage. It was found that there are four different old fluvioglacial gravel deposits, each of which is connected with a drift sheet. The gravel deposits are known as the "Aeltere Deckenschotter, Jungere Deckenschotter, Hochterrassen, and Niederterrassen," while the corresponding drift sheets are named "Gunz, Mindel, Riss, and Würm," the names being taken from type localities in the Alpine foreland. The relative ages of the deposits of each glaciation are determined by a study of the relative amounts of geologic work accomplished by erosion, sedimentation, and weathering since their deposition. The first two glaciations are found to be much more remote than the last two, and form what are called the older group, while the Riss and Würm form the younger group, yet the alteration of the Riss is sufficient to indicate that it is more than twice as old as the Würm. The classification here made was found to hold good throughout the entire Alpine field, and as a result of the wider study the relative ages of the several glaciations, as summed up in the concluding Lieferung, place the Riss three times as far back as the Würm, and the Mindel at least twelve times as far back as the Würm, while the Gunz is considered about one and one-half times as old as the Mindel, the data for estimating its age being rather imperfect. In this first volume Penck brings out clearly the minor oscillations shown in the last or Würm glaciation. To each readvance made by the ice he applies the term stadium and recognizes three that lie between the maximum limits of the Würm glaciation and the limits of the present glaciation, namely the Bühlstadium, Gschnitzstadium, and Daunstadium. These stadia are found to be capable of differentiation in many other parts of the Alps. This first volume also discusses briefly the interglacial deposits and the difficulties of their interpretation. It is the custom of these authors to class deposits as interstadial rather than interglacial except in places where the evidence is very clear that they were laid down in a much warmer climate than would be consistent with a glacial stage. Where, for instance, warm-climate plants are found to be imbedded in the deposit, as in the Hötting breccia near Innsbruck, the deposits are referred confidently to an interglacial time.

While the first volume is entirely from the pen of Penck, it should be stated in justice to the work done by Brückner, that the results of his studies in the Salzach district, which appeared in 1886 in the form of a monograph are here abstracted by Penck.

In the second volume which deals with the glaciation north of the western Alps, Brückner discusses the glaciers of Switzerland, while Penck discusses the Rhein glacier and the portion of the Rhone glacier in France and the Isère glacier. Penck also discusses the Quaternary fauna and Paleolithic man in the Rhodanischen district and on the north side of the Alps. The four glacial stages brought out in the first volume are clearly represented in the district covered by the second volume, but there is an interesting difference in the relative extent of the Riss and the Mindel glaciations in the two districts. In the eastern district the moraines of the Mindel glaciation generally extend beyond the limits of the Riss, but in the western district the Riss usually marked a greater extent of glaciation. Brückner has suggested elsewhere that a considerable part of the Quaternary uplift in the western Alps may have fallen in the Mindel-Riss interglacial time, and that this, rather than a greater depression of the snow line, accounts for the great extension of the Riss glaciation in that region. In the present discussion, however, the question is left open as to whether the Riss or the Mindel experienced the greatest depression of the snow line. Both glaciations were more extensive than the Würm and also than the Gunz. This western region is exceptionally favorable for studying the relations of the Quaternary fauna to glaciation, and also Paleolithic man in his geologic relations. The transformation of the fauna of the glacial period is found to correspond closely to the change from glacial to interglacial conditions. On the north side of the Alps there appears an Arcto-Alpine fauna characterized by the mammoth, wooly rhinoceros, and reindeer, and an interglacial fauna characterized by the ancient elephant, *Rhinoceros Mercki,* and the deer. In Switzerland there is a sharp line separating the two Arcto-Alpine faunas from an intermediate interglacial fauna, though there are occasional occurrences of a mixing of the two faunas, for example of the deer and the reindeer. The geographic extension of the localities in which each of the Arcto-Alpine faunas occurs furnishes a basis for correlating their occurrences with stages of the glacial period. The older fauna comes up about to the limits of the Riss glaciation, while the younger fauna extends to the limits of the Würm, in fact it extends about to the limits of the Bühlstadium, and thus shows its somewhat close correspondence with the Würm glaciation.

The stage of human culture apparently prevalent at the time of the Riss-Würm interglacial period is that designated the Moustérien. By the close of the Würm glaciation the culture had advanced through the Solutréen to the Magdalénien. What is regarded by Penck as the most impressive case of the occurrence of a Moustérien type of artifacts with an interglacial fauna came to notice subsequent to the publication of this volume, but is discussed by him in the eleventh or concluding Lieferung. It is known as the Wildkirchli locality and is found in the Ebenalp of the Santis, east of the upper Rhein and south of Wallen See. Explorations by Emil Bächler, of a cave which stood above the limits of glaciation in that region, at an altitude of about fifteen hundred meters, shows the presence of hundreds of stone artifacts, of the Moustérien type, imbedded with an interglacial fauna represented by the cave bear, cave lion, *Cervus Elaphus*, etc., in about five meters of cave earth, which is covered by rubble to a depth of 0.8 meter.

Penck holds that the cave earth calls for a thick vegetation in the district above the cave, and that the presence of these animals also strongly suggests such vegetation. He concludes that when these bones and artifacts were imbedded this region was warmer than now, for the cave is near the present timber line. There is no evidence that the fauna, whose remains are here imbedded, has occupied the region since the last or Würm stage of glaciation. This fact, taken with the stage of culture shown in the artifacts, gives a strong presumption of, if it does not clearly prove, man's presence there prior to the Würm stage of glaciation. Other instances, which have been cited to indicate man's presence prior to the last glaciation, such as those in the French Jura at Conliége, and Hautecour, are in Penck's opinion less clearly interpreted than the Wildkirchli.

In the third volume the Durance and several small glaciers on the west side of the southern Alps, as well as the glaciers on the east side of these Alps, are treated by Penck. Those on the south side of the Alps in northern Italy, are discussed in part by Brückner. Of those in the eastern Alps the Save glacier is discussed by Brückner, while the Drau and those of the Mur district are discussed by Penck. The conclusion (Schluss) which contains a résumé of the physiographic and climatic conditions, and the chronology of the glacial period, is by Penck.

The moraines formed on the borders of the Po plain in northern Italy reach enormous proportions, one on the edge of the Dora Baltea glacier attaining a height of about 500 meters above the low plain which it incloses, while those on the borders of Lago di Garda reach a still greater height above the bed of the lake. It is shown by Penck that the great Dora Baltea moraine, as well as those of several other glaciers, were formed mainly prior to the last or Würm glaciation. This was also the case on the north side of the Alps, but it has not been so clearly worked out in that region, though the outwash in the earlier stages points to more vigorous glaciation than obtained at the Würm stage of glaciation.

In the conclusion, which covers 36 pages, several points are more clearly presented than in the somewhat diffuse detailed discussion. Among these are: (1) The snow line of the several glacial stages in comparison with that of today; (2) the causes for the depression of the snow line; (3) difference between snow line and timber line in the ice age; (4) position of the snow line on the glacier surface, and the conditions of the zone of waste and zone of accumulation; (5) the rapidity of Alpine glacier movement in the ice age; (6) aspect of the different parts of the Alps in the ice age; (7) character of the fauna and flora on the north side of the Alps; (8) the loess; (9) the climate curve of the glacial period; (10) absolute length of postglacial time and of the entire glacial period.

We cannot enter into a review of each of these subjects but will speak only of the loess, and of the estimate of the absolute length of the glacial period. Typical fossiliferous loess is rather rare in the entire circumference of the Alps. Usually the deposit to which this term has been applied is a loam having some loess characteristics. This loam is best developed north of the Alps and is present on each of the older drift sheets, but not on the younger or Würm drift. Where there is an overlap of drift sheets it is found between them, in the position of an interglacial deposit. But while interglacial in position its fauna is not entirely of an interglacial type of warm climate animals. The mammalian remains in it are usually of the Arcto-Alpine type. Penck makes the suggestion that the loess was deposited in advance of a stage of glaciation in a sort of tundra condition with scanty vegetation. That the loess of the Riss-Würm interval closely preceded the Würm glaciation is indicated by the character of artifacts found at its base. They are closely allied to those which followed the Würm glaciation. The solution of the loess problem it is thought may be worked out more satisfactorily in the broad loess-covered areas of eastern Europe than in the rather limited area on the borders of the Alps.

As to the absolute duration of post-Würm time and of the entire glacial period, Penck attempts only to present data that will serve to indicate roughly its order of size. From Heim's estimate on the rate of growth of the Muota delta and similar estimates elsewhere in the Alps it appears that the Bühlstadium of the Würm stage of glaciation was reached between 16,000 and 24,000 years ago. It is safe to conclude, therefore, that the culmination of the Würm glaciation was somewhat more than 20,000 years ago. This estimate is borne out by a study of the Swiss lake dwellings in their geologic relations. They are more recent than the Daunstadium, and yet lie back at least 4,000 to 4,500 years. Inasmuch as the changes effected by geological agencies on the drift of the Riss glaciation are fully three times the amount effected in the drift of the Würm stage and the changes in the Mindel drift twelve times that in the Würm, the Riss glaciation would have culminated fully 60,000 and the Mindel 240,000 years ago.

The illustrations which accompany the work embrace many excellent photographs and several good maps as well as numerous diagrams. Among the maps that of the Etsch glacier and the moraine amphitheater of Lago di Garda, and the map of the Drau glacier and its neighbors, are the most complete, since they indicate the upper limits of glaciation by means of isohypsal lines. The data for such maps involve a vast amount of work such as it was not possible to extend over the entire Alpine field. As a rule each determination of the upper limits of glaciation required an all-day climb. Penck once remarked, in the presence of the reviewer, that his ascents and descents of mountains in the Alps involve a distance sufficient to reach from the Alps to the South Pole, or from the Alps to the North Pole and back again. One who has not attempted Alpine work can scarcely appreciate the great labor involved in carrying out such a study as that accomplished by Penck and Brückner. The only serious defect noted in this publication is the absence of a general map of the entire Alpine region, though this is offset to some extent by the adoption of a uniform scale (1:700,000) for the several maps of the sections of the Alps. It is also to be borne in mind that even at the culmination of glaciation the Alpine region did not support a continental ice mass. The glaciers which became united on the Alpine foreland were of the Piedmont type, and many glaciers remained entirely independent throughout their course.

Die Alpen im Eiszeitalter, although an expensive publication, the cost of the eleven parts being 55 Marks, or about $13.00, cannot well be left out of the library of any active geologist, and should be included in every university library. By those who have not a command of the German language a large amount of information may be obtained from the excellent maps, views, and diagrams.

FRANK LEVERETT

The Life of a Fossil Hunter. By CHARLES H. STERNBERG. Introduction by HENRY FAIRFIELD OSBORN. New York: Henry Holt & Co.

The author of this interesting personal narrative is one of the oldest vertebrate fossil collectors in America. Mr. Sternberg made his first expedition in the Kansas chalk for Professor Cope during the summer of 1876. Specimens collected by him from many of the vertebrate-bearing horizons of the western United States are to be found in many of the museums of America and Europe. Beginning his work at a time when America had but three vertebrate paleontologists, Mr. Sternberg has seen the science advance until now there are over forty specialists engaged in it and to this advancement he has contributed not a little by his industry and skill as a collector. He has persevered in his chosen work in spite of hardships and financial difficulties. His wide acquaintance with paleon-